

freight cars, or fifteen passenger cars, each 56 ft. long. The boat (Fig. 1) is 280 ft. long over all and 17 ft. 3 in. deep; the breadth of the hull is 45 ft., and the breadth over the guards 74 ft. 6 in. When light with coal on board she will draw 9 ft. forward and 10 ft. aft; with twenty-one loaded cars her draught will be about 11 ft. forward and 12 ft. aft. The Detroit River, through which the Transfer plies, is subject to serious accumulations of ice. To enable the boat to break her way through them, she is formed with an exceedingly heavy bow, having a vertical section like a sledge runner (Figs. 1 and 5), and strengthened by extra strong keelsons and additional bulkheads. Her powerful engines cause the bow to ride up on the ice, breaking it down and separating it to leave a lane for the passage of the vessel. To aid the ice breaking, the paddle wheels, 27 ft. 6 in. in diameter, have their wooden arms and floats incased in steel, the weight of each being 66 tons. The blows of the floats break up the pieces of ice parted by the bows. When the steamer made its first trip to Detroit on January 13, 1889, the run from the yards of the builders, the Cleveland Shipbuilding Company, Cleveland, was made in eleven hours and twelve minutes. For an hour and a half the speed was reduced, and for fifty miles the steamer broke her way through ice 4 in. to 6 in. thick. Her average speed in open water was twelve miles per hour, and this was only reduced to ten miles per hour through the ice.

The hull is covered with a steel deck and has a collision bulkhead forward, in addition to bulkheads between the store room and engine room, between the engine room and boiler room, between the boiler room and the after engine room, and at the end of the stern tube. Between the bulkheads belt frames occur on every sixth frame, except for 60 ft. in wake of the paddle wheels, where they occur on every other frame.

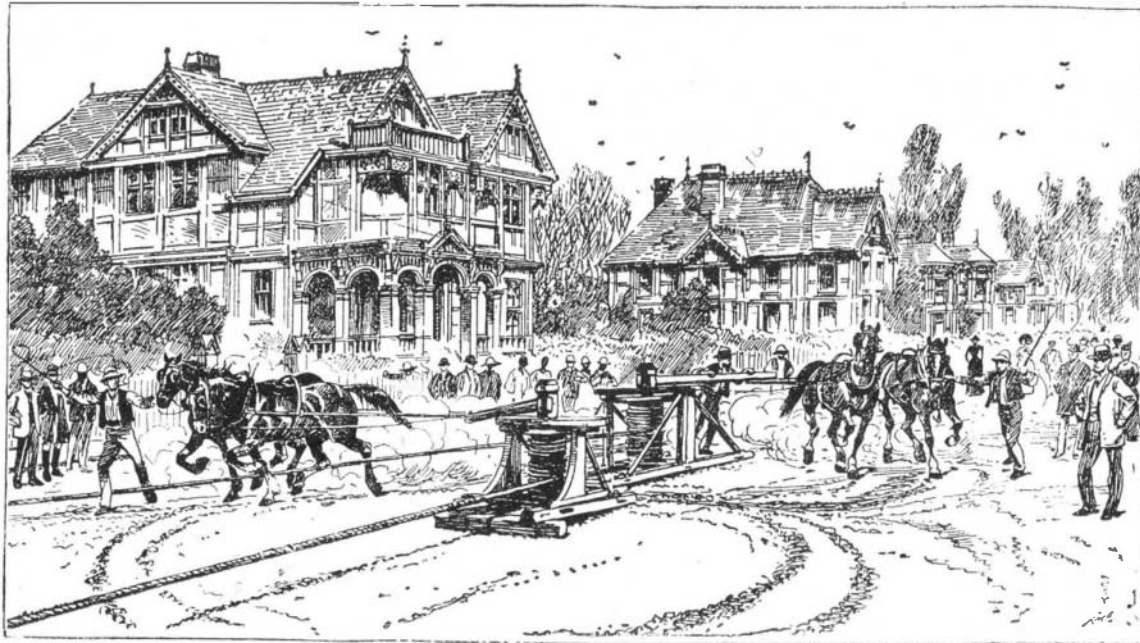
In addition to the paddle wheels, there is a screw propeller 9 ft. 6 in. in diameter, also designed for breaking heavy ice. The screw shaft is 10 in. in diameter and 52 ft. long, and is inclined 2 ft. 4 in. in 49 ft.; the propeller projects 12 in. below the hull proper, being protected by a solid forged skag, which carries the bottom pintle of a solid forged rudder. To protect the rudder when backing in heavy ice, there is a heavy forging immediately over the rudder, and extending down to its top line. This forging is covered by the outside plating of the hull, and when backing into heavy ice the rudder is put amidships and a heavy bolt inserted through the forging into the rudder frame from the deck, thereby holding the rudder rigidly in a fore and aft direction. The after end of this forging extends down over the after corner of the rudder to prevent ice being in between the rudder and the horn.

The paddle engines (Figs. 2 to 4) do not drive direct on to the paddle shaft, but communicate their motion through spur gearing. This consists of a cast steel pinion 5 ft. 4 in. in diameter, gearing into a spur wheel 16 ft. in diameter and 5½ in. pitch. The spur wheel is built with a cast iron center and arms in two pieces,

and with a rim in twelve cast steel segments. All the teeth are machine cut. Each paddle wheel has its own independent engines and gear. These have each two cylinders, 28 in. in diameter by 48 in. stroke. These engines have their air pumps driven independently by a beam engine (Figs. 6 and 7) with a steam cylinder 16 in. in diameter by 36 in. stroke; this drives two air pumps and four bilge pumps, while its center column forms a jet condenser common to the two paddle engines.

The screw propeller is driven by a pair of horizontal engines (Figs. 8 and 9) having cylinders 28 in. in diameter by 36 in. stroke, with a separate air pump driven off the end of the shaft.

There are four boilers of the rectangular firebox pattern, 11 ft. 6 in. in diameter and 16 ft. long, carrying a working pressure of 90 lb. The aggregate grate surface is 250 square feet, and the heating surface 9,828



HOUSE MOVING IN SAN FRANCISCO.

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Along the center line of the hull, between the boilers, are two steam drums connected to a steam separator. The funnels are at each side of the hull, and the bunkers amidships between the boilers, extending the full length of the boiler room.

Every room and compartment of the hull and paddle houses is supplied with coils of pipe for steam heating. On account of the great difficulty of getting water when working in ice, this vessel is provided with ten sea cocks, located in different parts of the ship. In engine room is a Reynolds patent heater, 42 in. in diameter, 10 ft. high, also three pairs of duplex steam pumps for fire purposes, feeding boilers, washing decks, pumping bilges, etc.

The career of this ferry boat will be watched with a great deal of interest, and if successful will certainly lead to other boats of the same type being built. It must be a very fine sight to see her plowing her way through ice six inches thick, as if unconscious of its presence, and leaving it behind her broken into fragments by the blows of her ponderous paddles.—*Engineering.*

HOUSE MOVING.

WE give some illustrations showing the process of house moving in San Francisco. The house in question is an ordinary wooden villa, and it was removed to a vacant lot half a mile distant. The first process is to put cross beams under the building; these rest on two other beams—one on each side—and these again rest on short rollers at each end. Then by means of horse power applied to a winch, the house is moved in the required direction, out into the street, and along it, turning corners, and until the building is landed at the desired spot. This is an everyday occurrence in San Francisco, and it frequently happens that the occupants continue to occupy the house while it is being moved.

THE PHYSIOLOGICAL BASIS OF THE SENSE OF BEAUTY OF FORM.*

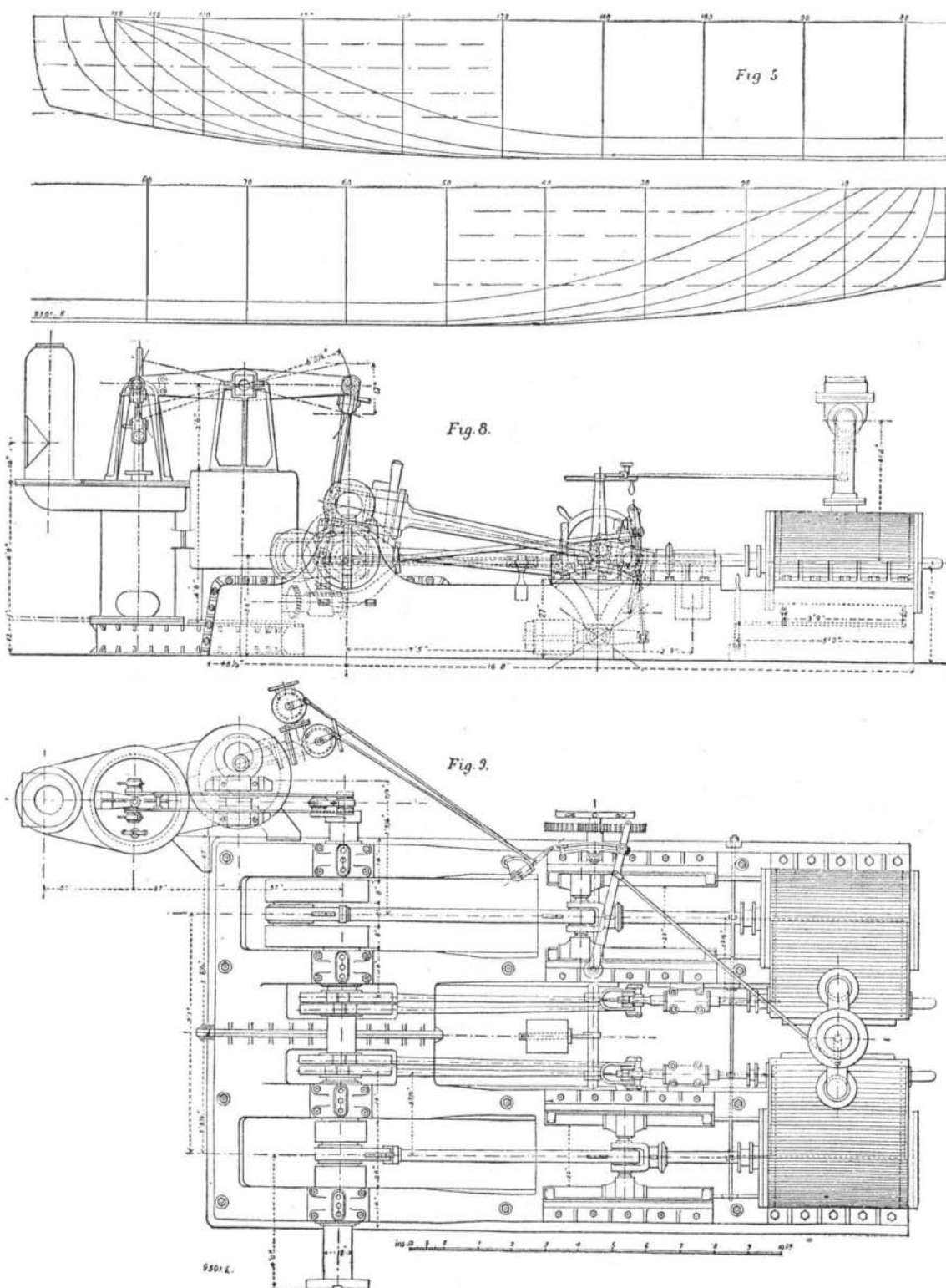
By ALBERT GOODMAN.

NO apology will be needed for this subject on account of its being unworthy of your attention, for its proper investigation requires the combined powers of various sections of the scientific and artistic world. The only reason it is not more frequently dealt with seems to be that it does not happen to fall exclusively into any one department of human study. To do full justice to it, the knowledge of the artist, the anatomist, the engineer, the mathematician, the optician, the physiologist, and the anthropologist could all be usefully employed. In introducing this subject I think myself fortunate in being favored by the obliging attention of a society such as yours, which, in such a matter as this, is to be preferred to that of any other profession. I conceive we have no professional body which occupies a similar position to that of a society of architects; for both collectively and individually an architect has to be, not only a jack of many trades, but also master of each one of them. The architect must be master not only of the principles of the various trades which carry out his conceptions, but he has to share their technical knowledge to a large extent. All this necessitates a philosophic mode of thought combined with highly mechanical and artistic powers. It is just this combination of mind which is requisite to solve such a problem as that before us.

The sense of beauty in general is a highly complex mental feeling. The sense of artistic beauty is somewhat less complex. The mental sense of artistic beauty of form alone is of a more simple nature. The term beauty used in connection with art is interchangeable with enjoyment or pleasure; for that which is artistically beautiful is enjoyable, and that which is artistically ugly is painful in the art sensations produced by it.

We have here to consider the beauty of form rather than the beauty of color, or the beauty of texture, or the beauty of alternation or gradation of light and shade. Some may have a little difficulty in abstracting the idea of form from that of color, not being in the position of a man who is born color blind, and

* A paper read at a meeting of the Society of Architects on February 25.—*The Architect.*



THE FERRY STEAMER TRANSFER.

thus has it already done for him. Turner's pictures, I understand, especially excel by reason of their coloring. Yet a skillful engraver can entirely dispense with that element and still produce a copy of one of them which conveys many of the artistic merits of the original. Apart from connection of ideas with regard to his subject and beauty of texture in his material, the sculptor has little besides beauty of form to depend upon. This connection of ideas is apt, more than we are aware of, to obscure many of our finer artistic feelings. For instance, a realistic representation of a snake, although its form may be rendered in an artistic manner, would produce pain rather than pleasure in some sensitive minds. One can well believe that a slave looking upon the beautiful curves of the whip lash would, through connection of ideas, fail to appreciate their artistic merit.

To arrive at the correct estimate of the art beauty of any form, we should choose some object that does not in our mind connect itself with the idea of an especial use or purpose. It is difficult to entirely fulfill this condition. Perhaps a beautiful vase is as good an object as any for practical experiment in analyzing sensations as to beauty of form. A design intended solely for ornament would do still better, being in itself far more free from any connection of ideas of use. But an ornament bears relation to those surrounding forms and outlines, apart from which it would not have been designed; nor can it be considered properly or to such advantage when isolated. But, to proceed, it goes without saying that in looking at any art form the eye, and the eye alone, is concerned in transmitting to the brain, or producing in the mind, the consciousness of the particular form observed. The eye, like a machine, acts upon the art object which may be instinctively thought of as the raw material, while the sensation of beauty may be regarded as the manufactured article. To vary the metaphor, the eye is the interpreter between the object and the mind, and he who would have his message properly conveyed must so arrange it as to be within the powers of the interpreter. To do this, he must know the limit and range of those powers.

In purely optical questions the eye is generally considered apart from the muscles which guide it, and is thought of as a system of lenses which project a picture upon the retina on the inner surface of the globe of the eye opposite the pupil. That the picture is there, and that some sort of an impression is conveyed to the mind by the mere fact of its being there, is not to be denied, but that any impression approaching in delicacy to an art sensation can be produced while the eye is unmoved, is not to be believed; and such an idea is negated by the very structure of the retina itself, which shows that the continuous and varied use of the eye muscles is a necessity for acute vision. Although like a globe in actual shape, the eye may be fitly likened to a photographic camera. The camera has compound lenses, so has the eye.

Both have a focusing apparatus; the camera has a piece of ground glass at the back, and the eye has a retina to receive the image. On the ground glass the photographer rules some lines in pencil to show the limit of accurate definition, and the intersection of two diagonal ones indicates the point where he intends that the most important part of the picture shall be brought by the adjustment of the camera, and where he will place the sensitive plate to receive it. The retina of the eye has just such another point or spot, vision being there most acute. When any object is carefully examined or examined at all, or perhaps one may say even looked at or consciously noticed, the eye is so moved as to bring in succession upon the sensitive spot each part of the image of the object that is engaging the attention. These eye movements are of course produced by the eye muscles, and are instinctively performed.

As we have said, impressions are conveyed without any muscular action to the brain by means of the optic nerve; these impressions are of course very vivid as regards color and amount of light, but in the particular matter of appreciation of art form, a retina rigidly fixed seems to have little or no power, indeed the ordinary appreciation of form is not nearly so acute as we are apt to imagine.

Until instantaneous photography came in, artists had failed, after years and generations of observation, to obtain a correct idea of the shape of a flash of lightning. For although the effect through the optic nerve was most intense and lasting, such is the inconceivable shortness of the time that even the excessive rapidity of the eye muscles could have no effect whatever in conveying exact appreciation of the form by bringing the outline of the flash successively on to the sensitive spot. Now that we are pretty well familiar with these photographs, we can easily persuade ourselves that we can now see distinctly and correctly that which we failed to see in years gone by.

We have then to consider how the muscles of the eye, like the arms of the photographer adjusting the camera, so move the globe of the eye as to cause each part of the image of the outline examined to pass over the sensitive spot. When a blind man endeavors to obtain an idea of the shape of an object, he moves his hands along its outlines by means of the muscles of his arms. If the object were moved by another person so that it touched the blind man's hand, no impression of form would be conveyed to the blind man's brain. Now the image upon the retina of the eye is like a little model of the outline of the object, and this model is within reach of the sensitive spot; and the sensitive spot, like the hand of the blind man, is moved along the image by means of the eye muscles. It is our purpose to consider the nature of the sensations of the eye muscles.

We of course, as a rule, use our two eyes in combination, but there is no reason to suppose that for artistic purposes a single eye would not be able to derive similar artistic pleasure from art forms. Indeed, the flatness of pictures not being considered a drawback to them, almost proves this. However that may be, it will be best to consider the action of one eye alone, remembering that in whatever manner the muscles of one eye are moving, the corresponding ones of the other eye are moving in just the reverse way.

Of the six muscles which move the eye, four are called the recti, and the remaining two are called the oblique. The four recti consist of two pairs, and the two oblique are also a pair; thus making three pairs. Each of these couples is called a pair, because one muscle pulls the eye one way and the other muscle pulls it in nearly the reverse direction. The superior rectus pulls the eye so as to aim it upward; thus

in looking at a vertical line this muscle would move the eye upward and its pair, the inferior rectus, would pull it downward, one resting while the other worked. The external rectus moves the eye along horizontal lines, and its companion, the internal rectus, pulls it also horizontally in the reverse direction. For the purpose we have in view, the superior rectus and inferior rectus may for convenience sake be called the vertical muscles, and the external and internal recti may be called the horizontal muscles. For working upon all oblique lines one horizontal muscle and one vertical muscle act in combination, and the same is true as respects all curved lines.

Having made these broad statements, which lead up to the solution of salient problems connected with vision, certain corrections must be added, which may enable us to solve some of the more recondite points connected with art sensations. It is not strictly true of all these muscles that each one acts in exact opposition to its companion. But, as with most muscles in other parts of the body, the vertical muscles slightly miss of this. Greater steadiness of movement in a joint results from the additional action of a third muscle, however weak it may be, provided that it pulls in a slightly different direction; just as a flagstaff is more steadily raised or lowered by three cords than by two. The eye, although not a joint, moves in a socket, and is no exception to the rule we have mentioned. The oblique muscle seems primarily and almost entirely designed for steadying the eye during all the movements to which it is liable. As this goes on without intermission, and as this seems to be their especial function, we will not take account of them for our present purpose, except as regards one class of lines, namely, vertical ones; these cannot be followed by a vertical muscle alone, but it calls in the assistance of one of the oblique muscles, which fact must be borne in mind when examining the art properties of perpendicular or nearly perpendicular lines.

The knowledge of the peculiar action of these eye muscles when used in observing straight and curved lines placed in certain positions with regard to the horizon, will help us to account for some of the otherwise inexplicable phenomena of visual and artistic sense: why, for instance, the moon looks smaller when in the sky than when near the horizon; why a man, say 200 feet distant, on a tower appears far smaller than the same man standing at the same distance on the level road; why an oval is more pleasurable to look at than a circle; why a square held vertically appears higher than it is wide; why a square placed with its side obliquely to the horizon produces a different mental impression than that produced by the same figure placed in the first position; why certain arrangements of lines are visually delusive; why certain races of men have consistently for many ages preferred certain curves and arrangements of lines which find little favor with other races; why the individuals of every race have certain differences of taste from their relations and neighbors, although subject to exactly similar mental training.

Beyond saying that it is the will of the Creator that these things should be so, which is hardly an intelligent solution to these difficulties, little has been done to solve these points, except upon the lines that visual impressions as to form have some intimate relationship to the movements of the muscles which guide the eye. Simple explanations offend a certain class of mind, which seems actually to prefer a mystery to such a solution of it; yet many of us who cannot charge ourselves with this weakness are very much startled when we observe how complex a result is brought about by simple causes. For instance, the whole banking systems of the world, without which commerce and manufacture would languish, are dependent upon the fact of the muscles of each man's hand being somewhat different from those of any other person. From this it results that an individual's handwriting and signature can be recognized and distinguished from that of any one else, in spite of similar educational influences from the school master. Yet how entirely unable would the anatomist have been to predict this result, however closely he examined the construction of the hands. Let us then be careful before we reject a similar theory respecting the muscles of the human eye, upon the ground that the proof of it should have been within the reach of the anatomist.

We must look for proofs in directions other than the physical examination of the muscles themselves. Of the fact that certain motions are pleasurable to the muscles, while other motions differing slightly are not pleasurable, we have many instances. How much lovers of cricket enjoy watching a batsman whose "style" is good! It is not that he is of necessity more effective in making a score; but he is evidently using his muscles, *i. e.*, moving his limbs, in a manner enjoyable to himself as contrasted with the man of no "style." The same is true with the figure skater. Both the skater and the observer enjoy it. The skater himself, not because the figure on the ice is elegant, but because he has learned to do it in a manner enjoyable to his own muscles. Certain arrangements of muscles render certain motions enjoyable, while another arrangement renders those motions distasteful. When we wave our farewells to our friends, our hands move in ovals, not in circles. The grindstone and the treadmill for the man and the mill for the horse are proverbially unenjoyable. In short, all pleasurable muscular movements have a certain character, and all tedious movements possess another character. Change and variety, exercise and rest, are necessary for each individual muscle, if it is to be a source of pleasure to its owner. Even human eyes do not seem primarily constructed to produce artistic pleasure, but art adapts itself to the construction of the eye. The bridle is made to fit the horse's head, and it is not, as the sportsman said, "that Providence has shaped the horse's head to fit the bridle."

But while art adapts itself to the eye, the eye trains itself to appreciate art. The trained eye of the artist can readily detect if any art object will give lasting pleasure to the ordinary man, or whether it will only give temporary pleasure. At a glance he can estimate that which the public takes a decade to experience. But the public is, for a time, pleased with anything which has a certain mixture of novelty from and resemblance to that which, just at that epoch, happens to be familiar to their eyes. Artists—and in that term I of course include all architects—artists have to appreciate all this, and in their wisdom act ac-

cordingly. But architects, especially, should never forget that behind and above all this there is a right and wrong in art forms, that the public is really trusting to them to keep this standard in mind, and not to depart from it more than is needful. The stronger our belief that there is such a standard of right and wrong in art, the more we shall search for it, and the nearer we shall attain to it.

Why should art be on a less assured footing than is music? And if the very natural question be put, "Of what practical use is a physiological theory as to the art sensations of form?" it may be said, in reply, that this subject holds the same relationship to art as the science of air vibrations and the construction of the human ear does to music. The identification of certain rapidities of vibration with certain musical notes, and the responsive action of certain parts of the ear to those vibrations, may not directly help a great composer in the remotest degree. Yet music, being placed upon the assured foundation of scientific consistency, reaps an advantage from it in many other ways.

We are living in an age of fierce public investigation. Neither commerce, literature, politics, nor religion has escaped; and it is only at the expense of being despised that any science or profession can escape this scrutiny. Ruskin, who cannot be accused of being a slave to popular opinion, has from his own point of view felt the need of bringing art nearer to the fraternity of the more exact sciences; and that which masterly use of language can effect, he has effected. Vague generalities have, I trust, been for ever banished by his magic wand; but in place of them he has supplied thought far more exact and fruitful, and ideas which serve as great encouragements to the young artist, who delights to find that his own artistic instincts are in agreement with his great predecessors, and are consistent with immutable laws common to all ages. If, therefore, we can to any extent explain the mode in which sensations are produced in the brain when the eye falls upon an object of art, we shall go far to place art itself upon a more assured footing in the public estimation. Beyond this, we shall have a better means of properly estimating, at all events intellectually, the artistic merits of the art productions of other races of mankind; a matter of no small importance to architects at the present time, now that we are being brought into increasing contact with foreign nations, and the English public is becoming familiarized with Eastern art.

The practical application of these theories will, I trust, be less tedious than the consideration of the theory itself. It is interesting to take certain art forms and draw their outlines in colors or any diagrammatic way, which will show the especial muscles used as each part of the object is brought upon the sensitive spot of the retina of the eye. Let two colors, say red and yellow, represent the use of one of those two which we have termed the vertical muscles, namely, red for the superior rectus, and yellow for the inferior rectus. Let brown and green represent the use of the horizontal muscles, namely, brown for the external (say the right) rectus, and green for the internal rectus. Blue and black may be used for the superior and inferior oblique muscles.

One eye alone, say the right, is taken into account; and that eye is supposed to be going round in a certain direction, say with the clock. First, take a square placed with its sides horizontally and vertically. This figure thus placed alternately employs a single muscle and then two in conjunction. The whole of the bottom line is green, showing that the internal rectus is alone employed upon that line. The left vertical line is red, showing that the superior rectus does nearly all the work, the top line is brown and the downward line yellow.

Thus each of the four great muscles works apart from the other four, and every muscle rests three times as long as it works. The horizontal muscles work alone, but this they are the better able to do, being relatively strong. The vertical muscles are weak, but receiving a little help from the oblique, they are thus slightly but not much more worked when looking at the square than are the horizontal muscles. That they are a little overworked is brought about by the fact that a square thus placed looks to be higher than it is wide. This may not be readily detected, but careful trial will prove it.

Man's easy range of vision, even with one eye, is more extensive horizontally than vertically. Hence the outline of the majority of pictures, especially large ones, is greater in that direction, not that the four straight lines which inclose a picture are for the purpose of inducing the eye to travel over them continuously, but they inclose an area over all parts of which the eye may pleausurably range. In the light of these ideas we can well understand that a vertical line will be more apt to be objectionable when unduly prolonged than will a horizontal one. Hence a dado will be an improvement in a high room, but may be inappropriate to a low one, and a wall paper with vertical lines will be more suitable to a low than to a high room.

Now place the same square with its sides at 45° with the vertical, and notice the great difference in its effect upon the mind. We hardly recognize it as the same figure. We now think of it as more resembling the diamond shape.

Beginning at the bottom, the first line is an equal admixture of red and green, the next of red and brown, then brown and yellow, then yellow and green.

In this case every muscle when working does half the work; and each muscle works half the time and rests half. The whole effect may be said to be fairly good, artistically, certainly better than when the square is otherwise placed.

Without the muscular explanation as to why the same figure produces a different mental impression when varied in its position relative to the vertical, we should have been at a complete loss, as we have nothing analogous to this in purely mental operations.

The color representation of the muscular action when used upon the circular image projected by the sense of the eye upon the retina shows that each muscle gradually commences to act, and stops equally gradually; and that no two muscles stop or start together; hence there is no particular point at which the eye can stop and reverse its action, or where it can easily glance off for the purpose of working upon to other parts of the object of the building, picture, or design, as the case may be. Hence there is no figure which tires the eye so much as does the circle.

The circle is, however, an extremely useful figure when used as an ornament, for it, as it were, entraps the eye, and is thus able to divert it from other lines which are inartistic.

When used for this purpose—and it is only for this that the unbroken circle should be used—it should subtend a small angle, as in this case it is not nearly so wearisome to the eye as when the circle appears large; for it is not so much what the muscles have to do which fatigues them as the number of degrees through which they have to move the globe of the eye.

Thus a circle should either be small, or only a portion of the whole 360° should be used. Hence the so-called Norman arch, whether stilted or otherwise, although consisting of as much as 180° of the circle, has an entirely different effect according to whether the arch is large or small relatively to the whole design. The oval, whichever way placed, presents, of course, somewhat the same features as the circle; with the exception that the relative proportion of rest and work of each muscle is different. It is therefore more pleasing as an ornament but less forcible when so used, because the eye can leave it with more facility. It is, therefore, best used in close combination with other lines.

But let us return to the circle, or rather the parts of the circle, for that curve is, *par excellence*, the one with which civilized architecture has to deal.

The poor we have always with us, and also the compass and straight edge. The civilized arts must ever chiefly avail themselves of such curves as the compass can produce. And in this necessity lies the great distinction, so far as art is concerned, between the architect and the artist or sculptor.

Civilization consists in the united efforts of individuals; and an exact appreciation of each other's ideas and acquisitions is the basis of this united action.

However grand and beautiful may be the conceptions of the architect, only such of them can be utilized as can be conveyed to another mind—an inferior one it is to be remembered—by means only of straight lines, angles, and curves, which can be measured and reproduced by simple instruments.

The compass is, therefore, the architect's necessity, and his endeavor should be to render it a useful slave rather than a tyrannical master.

I suppose I shall not be far wrong in saying that the particular curves and ornaments given to arches at the present time give the chief character to each particular style of architecture.

Those who first used the semicircular arch were of a vigorous race, but were more marked by their energy than by the delicacy of their feeling.

They found pleasure in the half circle used in combination with a bold, or even coarse, capital at the base of the curve. The unwearied muscles of their eyes needed but little rest or change; and when such a rest is taken, it is merely a change to an equally energetic recreation. As the color diagram indicates, the horizontal muscles are employed through the 180° of the curves, commencing and ending gradually. The vertical muscles work over 90°, commencing suddenly and ending gradually, or *vice versa*.

The Gothic arch, being suited to a more highly trained eye and to a mind which could more delicately appreciate its own sensations, only works the vertical muscles over some 60° instead of 90° of the whole circle, and the horizontal muscles over some 120° instead of 180°.

In addition to these advantages, the horizontal muscles commence just as gradually, and all through have less strain thrown upon them, while the capitals at the bases of the curves, whose purpose is again to refresh the muscles, may be of a less coarse form. Hence the Gothic arch, with its accompanying delicacy and varied carving, and the subtle tracery of its windows, is the glory of Western art, however ill adapted that style of architecture may be to the necessities of life.

The stilted arch, which seems to have been common to the Europeans and Moors, although so small a departure from the Norman, has yet a markedly more delicate effect upon the eye. This, perhaps, results from the more complete rest which the horizontal muscles receive after their exertion, as is shown by the color diagram.

The Moors neutralized the artistic evils of the half circle in another ingenious manner, however constructionally defective their arches may be. In their horseshoe arch they somewhat prolonged the curve by continuing the arch inward beyond the 180°.

The curious visual effect of this is easily explained by the color diagram, for it will be seen that, commencing where the Norman arch would end, a fresh horizontal muscle is worked for a short time, and then an entire rest is given to both muscles by a horizontal line making an acute angle with the curved line.

The Moors also modified their horseshoe arch by making a change similar to that from the Norman to the Gothic, giving the apex a pointed rather than a round form, accompanied with the consistent changes at the bases of the curve; but all of you will be much more familiar with these matters than I am myself.

Had there been no racial difference in art forms, the muscular theory would have been very one-sided and incomplete, however strong it might be against any other theory; but wherever a homogeneous race of men is found, there is also a distinct style of art. The gradual mixture of races, in some countries, confuses and obscures these differences of style.

Conquered races generally receive an admixture of the blood of their conquerors, and hence cease to be homogeneous in their race and also in their art forms, for the influence of the conquering race will be detected for an indefinite period after such an admixture.

The pure Tartar race, in the general conformation of their bodies, perhaps exhibit more vigor, and are to our eyes more uncouth than any other nation, and their style of art exactly corresponds to this description.

Again, the Arab races present physically, perhaps, the finest examples of grace combined with activity which the world can afford, and here again their art forms correspond thereto.

What these two races have done by successive attacks upon the other nations is within easy historic reach. The effect of these two great waves of influence, each starting from the home of the race, may still be seen.

The more ancient art forms of Egypt and Greece had already become, as it were, petrified long before this,

and they stand up as rocks in the midst of this sea of Tartar and Arabic art influence. But European art of the last thousand years seems to be the resultant of the meeting of these two waves upon the Celtic and Scandinavian races, and the resultant of these various forces is exemplified in the Gothic style of architecture.

It may be of less interest to us as Europeans, but from a cosmopolitan point of view it should also be noted, that the Malay archipelago is the center of a third great racial form of art.

Japan seems to be the meeting point of this Malay type and the Tartar type as modified by the Chinese. And India seems the meeting point of all these three waves or influences.

I will not further pursue this branch of the subject, nor will time allow me to adduce as arguments the interesting correspondence between the art forms and the cursive handwritings of various nations, especially as I have already alluded to the individuality of handwriting.

The next diagram I will trouble you with is the outline of a vase. A closed and irregular figure such as this, by the breaks in the line of any one color, indicating the use of one muscle, better illustrates the successive and the proportionate work and rest of the muscles in a good art form than will the more geometric forms we have been considering.

Any artistic picture, whether inclosed in four lines or otherwise, may in like manner be considered as a complex and interlocked system of outlines, skillfully so arranged by the artist that the eye of the observer is pleasantly exercised thereby, as, with inconceivable variety and rapidity, it travels in all directions, leaving no part of the picture unvisited.

Of course, in a picture, although not colored, gradations and alternations of light and shade take the place of that which we have termed outlines. But the addition of these new elements, and also the more complex one of color, while they add to the intricacy of the subject, also add to its interest and importance. In alluding to its principles of ornamentation we must remind ourselves that although for our present purpose we speak of outlines only, and also speak of those outlines as though they were hard lines, yet a graduated shade or the line of contact of two colors is for our purpose virtually an outline—its attractive force to the eye being according to the difference between the two colorings or the abruptness of the change of shade.

Some people who are not minutely observant of their own sensations are somewhat skeptical as to whether the eye does or can move with the immense rapidity and in the intricate manner alluded to.

They can, however, prove this to themselves by noticing the extreme speed with which the eye can run down whole columns of mixed names or words, detecting the one sought for directly the eye meets it, for it is self-evident that each previous word has been examined.

Again, by intently observing the engine turning on a watch case, the dizzy feeling it produces, owing to the eye continually moving along circles alone and those of exactly the same radius, would confirm the idea.

Again, some people, who do not give sufficient importance to the muscular theory of visual impression, or who disbelieve it, have found themselves puzzled to account for the fact that whereas the image on the retina of the eye is upside down, we see it, as they express it, right way up. Of course there is really no "up or down," "left or right," to a mental impression. Nor is there to a visual impression, except as respects the movements of the muscles. Let us suppose we are looking at a church spire; then the image on our retina is with the spire pointing downward. Let us say the point of the spire is below the sensitive spot. When the muscles of the eye aim the globe upward to the point of the spire, the image of the point comes upward on to the sensitive spot.

Thus the upward movement of the eye becomes connected in the mind with the top of the object looked at, the downward movement with the bottom, the leftward movement with the left side, and the rightward movement with the right side of the object, and all our muscular sensations accord with the real position of the object looked at.

According to the same theory which we are considering, the principles or ornamentation are not far to seek. The general effect of any structure may be, or may not be, pleasing to the eye. If it be pleasing, it will require no ornament. If it be unpleasing, ornament becomes a necessity. But this is putting the matter in far too bold a manner when applied to an important work of art, such as a large building. And for this reason: The whole of such a building can never be seen at any one time, and every part will be looked at from a variety of distances. The influence of distance upon any line, as to the effect on the eye, is of great importance.

Relative size of lines in art is self-evidently of supreme importance, as the whole thing depends upon that, but actual size, although all other parts are increased or decreased in the same proportion, is also of much consequence.

As we have pointed out, it is an entirely different thing to the eye whether it looks at a large circle or a small one, or, which comes to the same thing, whether the circle it looks at is near to or far off.

A building, then, looked at from a certain distance, may require no decoration, but when viewed nearer may be ugly unless that ugliness be corrected by decorative additions, or by slight or harmless modifications of the structure.

When the eye is so close to a wall that no part of the structure of the wall is seen, the texture of the external substance of the wall acts as a decoration by giving the eye fit employment. On stepping farther back, the texture is lost sight of, and at this point some structural lines, such as the joints of the stones, come into view. But if the texture is lost sight of before some such structural lines employ the eye, the wall must be decorated, and the size of the pattern of this decoration must be such as to employ the retreating eye until the observer can catch sight of some structure or ornament. Thus the wall paper of a large room must have a larger pattern (supposing panels or dados, etc., are not used) than one employed for a small room.

But let us imagine the observer to be so far away that some portion of the structure does catch his eye; at this point all texture and small decoration lose significance, and ornament may be needed—but only in

case of the lines of the structure then in sight not happening to be such as would please the eye.

In that case an ornament becomes needful, but this must not be too coarse, too heavy, too marked, or too strong (whichever adjective is most appropriate to the nature of the ornament). We say, the ornament must not be such as will arrest the eye when the eye is at such a distance as to allow of a more comprehensive view of the whole structure.

To sum the matter up in a sentence. When the form of any structure, say a building, is not pleasing to the eye, that is an evil which should be remedied as far as possible by ornament; but if the remedy does not cease to have visual effect at the distance at which the evil is lost sight of, then such ornament becomes an evil, and the remedy may prove worse than the disease.

I have endeavored to place the whole subject before you in its broad and comprehensive form. Hence I have not attempted extreme exactness in anatomically describing the combined action of all the six eye muscles. But I believe you will find that the differences between anatomists as to these matters leave our theory unaffected. And had we still further simplified the matter by only taking into consideration one of the horizontal muscles, together with one of the vertical or even the superior oblique and the external rectus, and examined the effects upon those alone, I believe most of the points we have noticed would have been brought out nearly if not quite as well.

I cannot, of course, for lack of time, now deal with the more fascinating part of my subject, which consists in the application of the muscular theory to details of ornament such as to the exact sizes of circles, to the proportions of ellipses, spirals, quick and slow curves combined, contrasted curves, zigzags, angles acute and obtuse, chequerwork, the inclinations of roofs and spires, etc.

In conclusion, I must make my apologies to such an assembly as the present for having touched upon so many points in which you are experts. But such errors as I have fallen into will not, I think, be found to affect the general scope and bearing of the subject.

EMILE MULLER AS A CERAMITIST.

EMILE MULLER was not only an eminent engineer and a brilliant professor, but he was especially and above all a ceramitist, and applied all the qualities of precision and scientific method, which characterized him to so high a degree, to the practice of a calling in which success is very difficult. In fact, there are few industries that require an amount of knowledge so varied, and in which true science is so indispensable. This is something that is not well known or not generally admitted. How many persons are there who fancy that it suffices to put into the fire any sort of argillaceous earth in order to take it out a perfect brick or a faience of fine quality! How many manufacturers are there who are regarded as illustrious on account of a few fortunate successes, who are unable to reason as to their success!

The question of art left aside, a good ceramitist should, before all else, be a scientist.

As an accomplished chemist, he should study the composition of the earths that he has in hand, he should know how, for a definite purpose, to associate with the argillaceous material (the basis of his industry) the substances that will give it the requisite qualities, he should know how to modify the relations of these elements according to the nature of the final product that he is endeavoring to obtain, he should compel himself to analyze his mixtures in order to assure of the constancy and regularity of his wares, and should so calculate and prepare the composition of coverings and glazes as to make them harmonize strictly with the clay mass that they cover, or else run the risk of seeing them crack or swell through the effect of unequal expansions.

As an experienced physicist, he ought to search for in his crude material, or communicate to it, those qualities of plasticity and homogeneity that are indispensable in moulding, and that are necessary for giving the desired strength to the manufactured products, he should study the question of the temperature adapted to each material, he should regulate the action of the gases that exert so varied effects upon colors, and he should be able to construct apparatus in which the heat is well utilized and properly distributed in order to obtain during the successive bakings of the same nature a perfect and uniform constancy, as each clay mass and each glaze acquires its absolute and relative qualities only at a definite temperature.

Such are, in a general way, the attainments indispensable to an enlightened ceramitist, to the man who relies not upon chance (to which we too willingly ascribe a preponderant role in the art of firing), but upon science, whose rules are immutable. Muller possessed these in all their detail. Profound study had developed the qualities that were born with him, and rendered him capable of giving success and prosperity to his industry.

The Ivry Port Works, near Paris, were founded by Muller in 1854. At this epoch their exclusive object was the manufacture of bricks and tiles, but they did not long follow this limited field of operations. Muller was one of the most ardent promoters of the application of ceramics to architecture and of its association with metallic constructions. The Universal Exposition of 1878, and that of 1889 especially, showed with what boldness he had entered this path, and the unusual dimensions of the pieces that he has been able to produce testify both as to the security of the processes and the extent of his means of action. It is almost useless, *apropos* of the late exposition, to recall the large part that Muller took in the external decoration of its marvelous palaces: The eight Allard medallions with children, which are 5½ ft. in diameter, the four great Darwin friezes with lyres and rams' heads, the four pyramids that decorate the entrance porch of the Palace of Liberal Arts, with Michel's statues (*Pax et Labor*), the forty-eight vases, 11 ft. in height, that surround the great blue domes, etc., are still present to the minds of all. They excited the astonishment of connoisseurs and the admiration of everybody.

To the manufacture of terra cottas, Muller began in 1866 to join that of glazed products. In collaboration with the lamented Parvillée, he produced large pieces of all colors for the exposition of 1878, and, since then, he has given this part of his industry a wide development. The exposition of 1889 showed us all the advantage